May 15, 1928. 1,669,448

S. BRAND

MULTIPLEX SIGNALING SYSTEM

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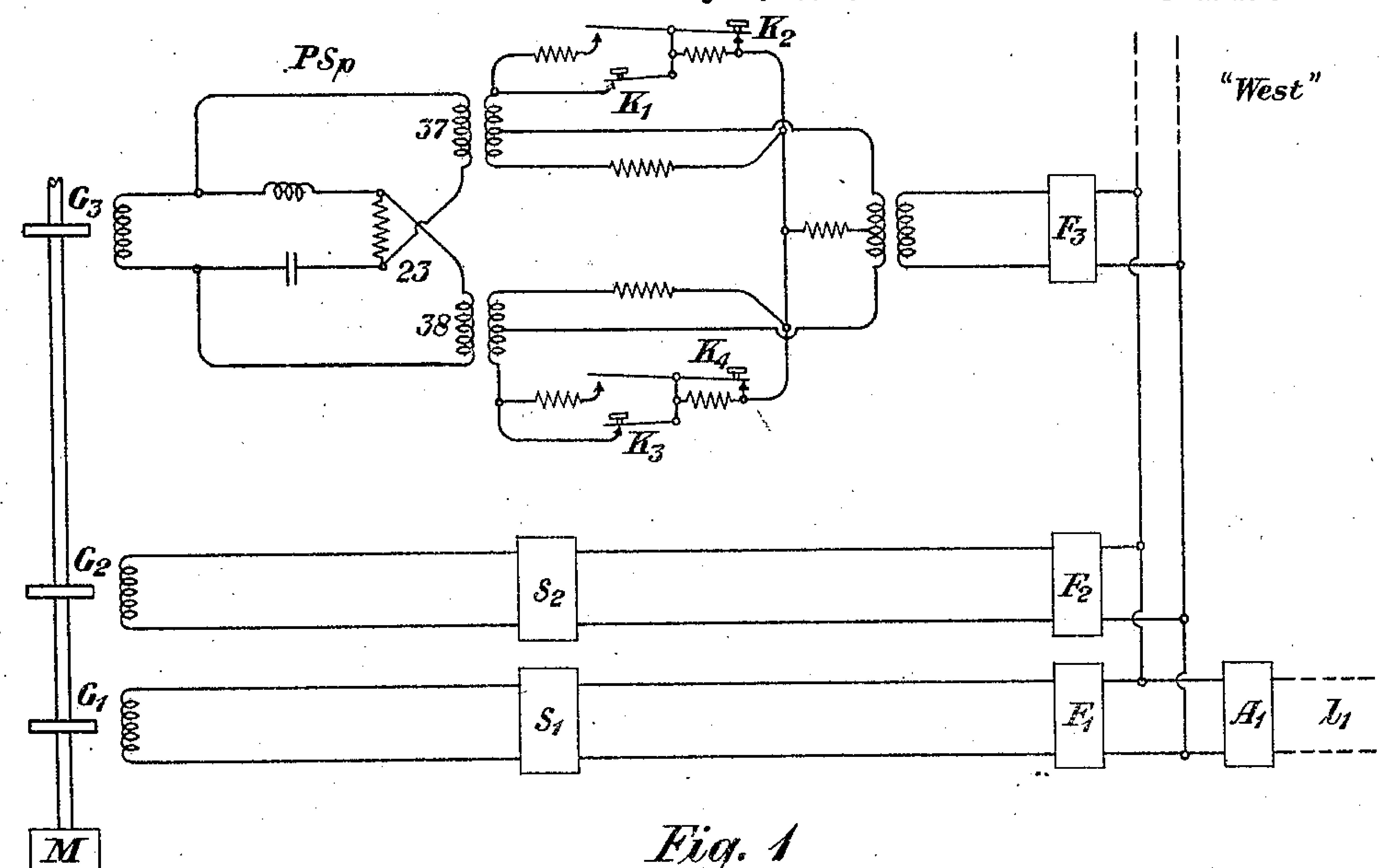

Fig. 1

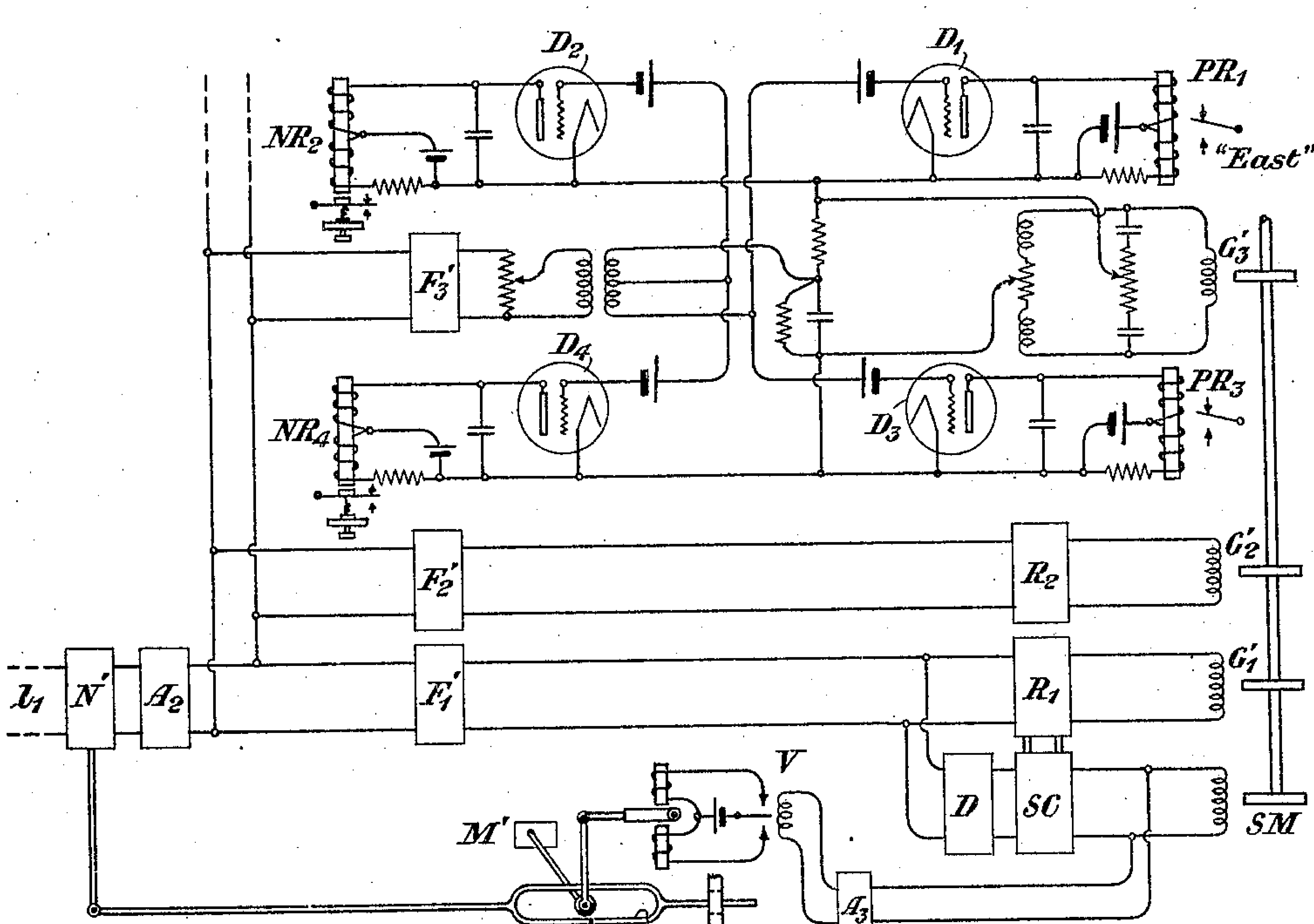

Fig. 2

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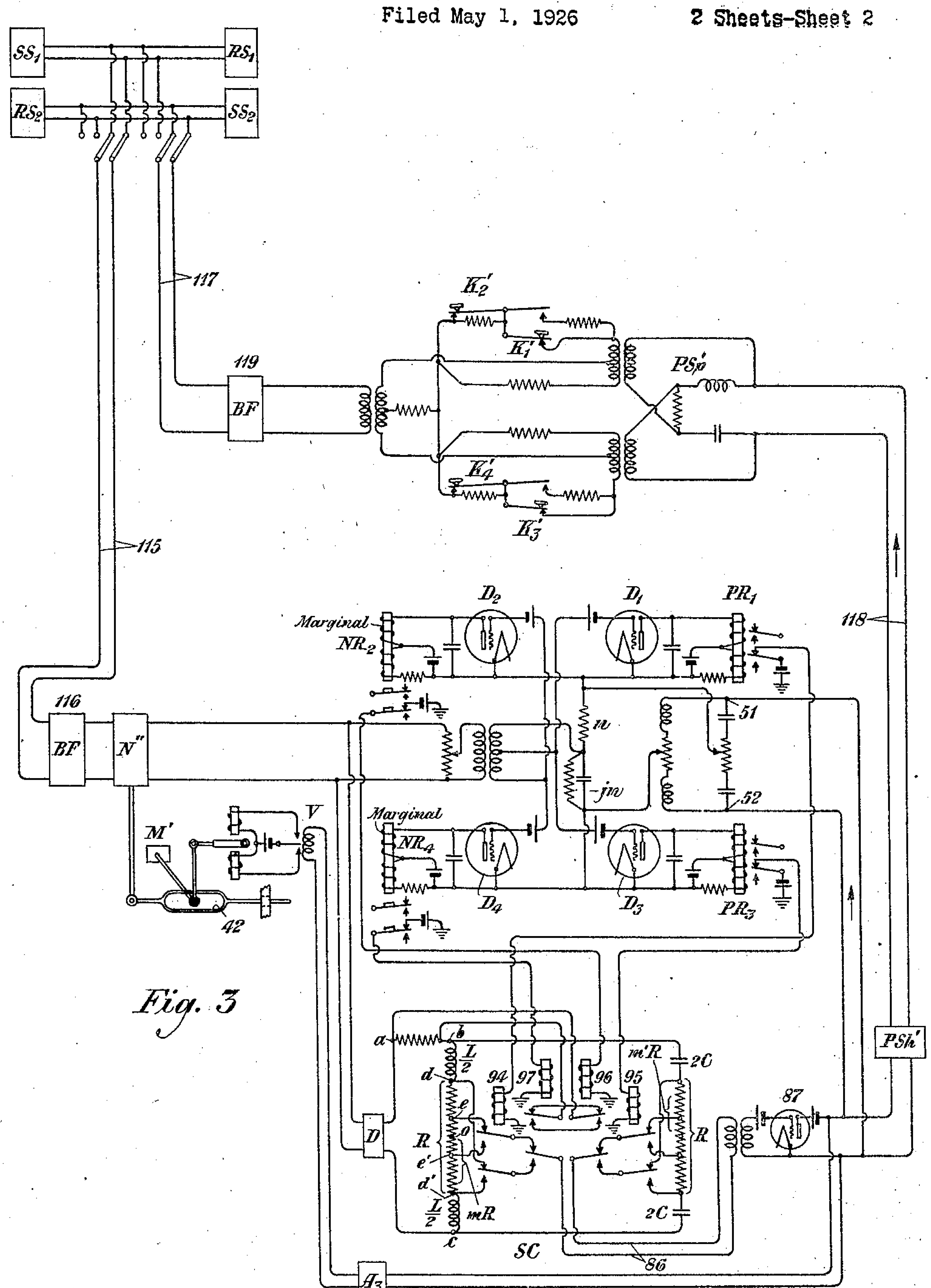

Fig. 3

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UNITED STATES PATENT OFFICE.

SMART BRAND, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

MULTIPLEX SIGNALING SYSTEM.

Application filed May 1, 1926. Serial No. 106,098.

It is an object of my invention to provide a new and improved system of multiplex carrier current signaling. Another object of my invention is to provide in such a system for operating a special station on only one or a limited number of the carrier frequencies. A further object is to provide a local source in connection with such a station for generating a pure current in proper synchronism and phase relation with the selected carrier current component of the system. These objects, and other objects of my invention, will become apparent on consideration of an example of practice according to my invention, which I have chosen to illustrate and describe in this specification. It will be understood that this disclosure relates principally to this example of the invention, and that the invention will be defined in the appended claims.

Referring to the drawings, Figure 1 is a diagram of a sending station for multiplex signaling. Fig. 2 is a diagram of a corresponding receiving station, and Fig. 3 is a diagram showing a station adapted to send and receive on a single carrier frequency in connection with a system such as disclosed in Figs. 1 and 2.

The motor M in Fig. 1 drives the various generators G_1, G_2 and G_3 to produce currents of different frequencies which are preferably harmonics of a fundamental frequency. The current from each generator such as G_3 goes to a phase splitter PSp, from which two components of the same frequency 90° apart in phase go to the respective transformers whose primary windings are 37 and 38. Current of one phase transmitted through the winding 37 is controlled by the keys K_1 and K_2. The key K_1 reverses the phase of this component of current no matter what its magnitude, and the key K_2 changes the magnitude without affecting the phase.

The two components of current 90° apart in phase and each affected by phase reversals and magnitude changes as determined by the operation of the four keys K_1, K_2, K_3 and K_4 are superposed in the input to the band filter F_3, from which they pass to the line l_1.

At the receiving end, these currents pass through the adjustable artificial line N′ and the amplifier A_2 and are separated through respective band filters such as F'_3 which passes only the current of the same frequency as passed by the filter F_3 at the sending end. Accordingly, the output from the filter F'_3 comprises two components 90° apart in phase, each reversed in phase from time to time and each varied in magnitude from time to time, as determined by the operation of the four sending keys K_1, K_2, K_3 and K_4. These received current components go to the grids of all four detectors D_1, D_2, D_3 and D_4.

One of the received current components is passed by the band filter F'_1 and goes through the networks D and SC; these are like correspondingly designated networks in Fig. 3 which will be described presently. For the present, it may be stated that the networks D and SC operate to compensate signal modifications in the received current, so that the output from the network SC is a pure unmodified current of the particular carrier frequency to which the band filter F'_1 is appropriate. This output current from the network SC drives the synchronous motor SM in synchronism with the motor M at the sending end, and the motor SM drives the generators G'_1, etc., at frequencies corresponding to those of the generators G_1, etc., at the sending end. Accordingly, the generator G'_3 delivers current of the same frequency as passed by the band filter F'_3. This current from the generator G'_3 goes through the phase shifter and phase splitter shown and produces two electromotive forces 90° apart in phase, one of which is applied in the grid circuits of the detectors D_1 and D_2, and the other in the grid circuits of the detectors D_3 and D_4.

The detector D_1 has a polarized relay PR_1 in its plate circuit, whose armature stands one way when the received electromotive force and the locally generated electromotive force are in phase agreement, and stands the opposite way when they are in phase opposition. Hence the relay PR_1 is responsive to reversals of phase on one component of received current.

The relay NR_2 is a neutral relay, uninfluenced by phase reversals, but responsive to changes in magnitude, and, therefore it responds only to magnitude changes on one of the two components of received current. Thus it will be seen that each of the four relays PR_1, NR_2, PR_3 and NR_4 answers only to the operation of a corresponding key at the sending station.

The attenuation on the line may vary somewhat from time to time, and to compensate for this a voltmeter relay V is bridged across the output from the network SC and operates automatically to adjust the artificial line N′ so as to maintain the voltage on the said voltmeter relay V substantially constant. Since the artificial line N′ is in the path of all the received current components, they will all be held at substantially a constant level as they come into the various receiving networks.

Fig. 3 shows two sending stations SS_1 and SS_2 like that shown in Fig. 1, and two receiving stations RS_1 and RS_2 like that shown in Fig. 2, and Fig. 3 also shows a way station adapted for sending and receiving on one only of the multiple frequencies employed in the system of the foregoing mentioned four stations.

By means of the branch conductors 115, signal modified currents from the sending station SS_1 of one particular frequency are taken off and passed through the band filter 116 and the adjustable artificial line N″. These signal modified currents go to a receiving network like that shown in Fig. 2 where they are indicated respectively in the receiving relays PR_1, NR_2, PR_3 and NR_4.

The received currents through the band filter 116 and the artificial line N″ also go over a multiple branch circuit to the delay network D and thence to the signal compensator SC shown at the bottom of Fig. 3. This network SC consists of resistances and reactance elements provided with switches controlled by the relays 94, 95, 96 and 97. These relays in turn are controlled by armature contacts associated respectively with the receiving relays PR_1, PR_3, NR_2 and NR_4. The arrangement is such that as the signaling changes in the received current operate the respective relays of the receiving network they cause circuit changes in the network SC to compensate, so that the output current from the network SC over the conductors 86 is a pure current of the carrier frequency unmodified by the signal changes. This current goes through the amplifier 87 to the input for the receiving network across the points 51 and 52, the same as in Fig. 2.

Current of the same frequency goes through the phase shifter PSh' over the conductors 118 through the phase splitter PSp' and to the sending network controlled by the keys K'_1, K'_2, K'_3 and K'_4. The signal modified currents from this network go through the band filter 119 and the conductors 117 and are put on the line, as shown in the upper part of the drawing, for transmission to the receiving station RS_2.

The received currents from the line over the branch conductors 115 are compensated for varying attenuation by the adjustable artificial line N″, the same as in Fig. 2.

It will be seen that the system of Fig. 3 is designed for co-operation in a multiplex signaling system at only one of its many frequencies. At the station shown in this figure, there is no requirement for generating the fundamental frequency of the multiplex system, nor any other harmonic than the harmonic current of the single frequency employed for receiving and sending at this station.

I claim:

1. In a multiplex carrier current signaling system, the method of operating at a station at one of the various carrier current frequencies independently of the other such frequencies, which consists in filtering the current of that frequency to a receiving network, compensating the signal modifications in such current and applying it to cooperate with the received current in the receiving network.

2. In a multiplex carrier current signaling system, the method of operating a station at one of the various carrier current frequencies, which consists in filtering the current of that frequency to a receiving network, compensating the signal modifications in such current and applying it to cooperate with the received current in the receiving network, and also applying it for sending on that same frequency.

3. In a multiplex carrier current signaling system, the method of operating a station at one of the various carrier current frequencies, which consists in filtering the said current of that frequency with its signal modifications to the said station, determining thereby a local current of the same frequency freed from signal modifications and combining the received signal modified current with the said local current freed from signal modifications to operate detectors to discriminate a plurality of message channels in the said received current.

4. The method of receiving on a current of a single frequency, which consists in determining by said current the generation locally of a current of the same frequency but unaffected by signal modifications and combining this current with the received current, to detect the signals conveyed by the first named current of first mentioned frequency.

5. The method of receiving on a current of a single frequency, which consists in determining by said current the generation locally of a current of the same frequency, but unaffected by signal modifications and combining this current with the received current to discriminate among a plurality of message channels on said current and detect the signal indications in the respective channels.

6. In a multiplex carrier current signal-

ing system, a station adapted to operate on a single carrier frequency comprising a receiving network and a signal compensator to which received currents of that frequency are conducted, and means to apply the output of said signal compensator to said receiving network for co-operation with the directly received currents.

7. In a multiplex carrier current signaling system in which the various carrier currents are all harmonics of a common fundamental, the method of operating at a station at one of these carrier current frequencies without the need for developing the fundamental for such operation which consists in filtering the current of that frequency to a receiving network, compensating the signal modifications in such current and applying it to co-operate with the received current in the receiving network.

In testimony whereof, I have signed my name to this specification this 29th day of April, 1926.

SMART BRAND.